Space Weather Technical Forecast

Issued on Friday, 17 November 2023 at 13:22 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Increasing risk of M flares throughout the period.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has remained Low over the past 24 hours, with only isolated C-class flares, the largest of which was a C4 peaking at 16/2022 from a region which is currently emerging onto the southeast limb. There are two other sunspot regions on the visible disc, with AR3486 the most notable. The other region, AR3487 is a small and weak region. Both are in the western hemisphere, and have been stable.

There have been a few CMEs in the last 24 hours but none are expected to be earth directed.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by ACE and DSCOVR at L1, started at Slightly Elevated levels around 440 km/s but eased down to ambient and is currently around 330km/s. It is possible that a very weak connection to CH70/- did occur, as the Phi angle did become negative (towards the Sun) between approximately 16/1700-2100 UTC and again between 17/0300-0600. However, the rest of the time the Phi angle was mainly positive (away from the Sun), and so any connection to CH70 was weak and temporary. The solar wind density trend was unremarkable - complicated by the switch in measuring satellites but staying below average to average throughout. The IMF was weak, at or below 5nT, while the north-south component ranged between -5 and +4nT. The resulting geomagnetic activity was Quiet to unsettled (Kp 0-3).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux remained at Background levels. GOES16 high energy (greater than 2MeV) electron flux was predominately moderate throughout the period, with a peak of 277 pfu at 16/2025 UTC. The associated 24-hour fluence showed an increasing trend, but despite this remained below the Active threshold (1e8 integrated pfu) threshold. The fluence observation at 17/0001UTC was 7.19e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to remain Low, but with an increasing chance of isolated M-class flares due to the new region that is currently rotating onto the southeast limb, plus other regions that are expected to rotate onto the visible disc through the forecast period.

Solar Wind / Geomagnetic Activity: The CME associated with the 16/0100UTC filament eruption may reach Earth late on day 3 (19th), but confidence is low regarding this. Any arrival is unlikely to produce a significant geomagnetic response.

The solar wind is expected to remain at predominantly background levels today and much of tomorrow. Slightly elevated wind speeds may also occur from late tomorrow (18th) due to further coronal hole influence, from a new feature which has developed near centre disc. The influence of this thin coronal hole is likely to wane later in the period.

Geomagnetic activity is expected to remain predominantly Quiet (Kp 0-2), but with isolated Unsettled (Kp 3) intervals possible throughout, especially late tomorrow (18th) into day 3 (19th). There is a risk of a G1/minor storm (Kp5) on day 4 (20th) due to the possible arrival of the

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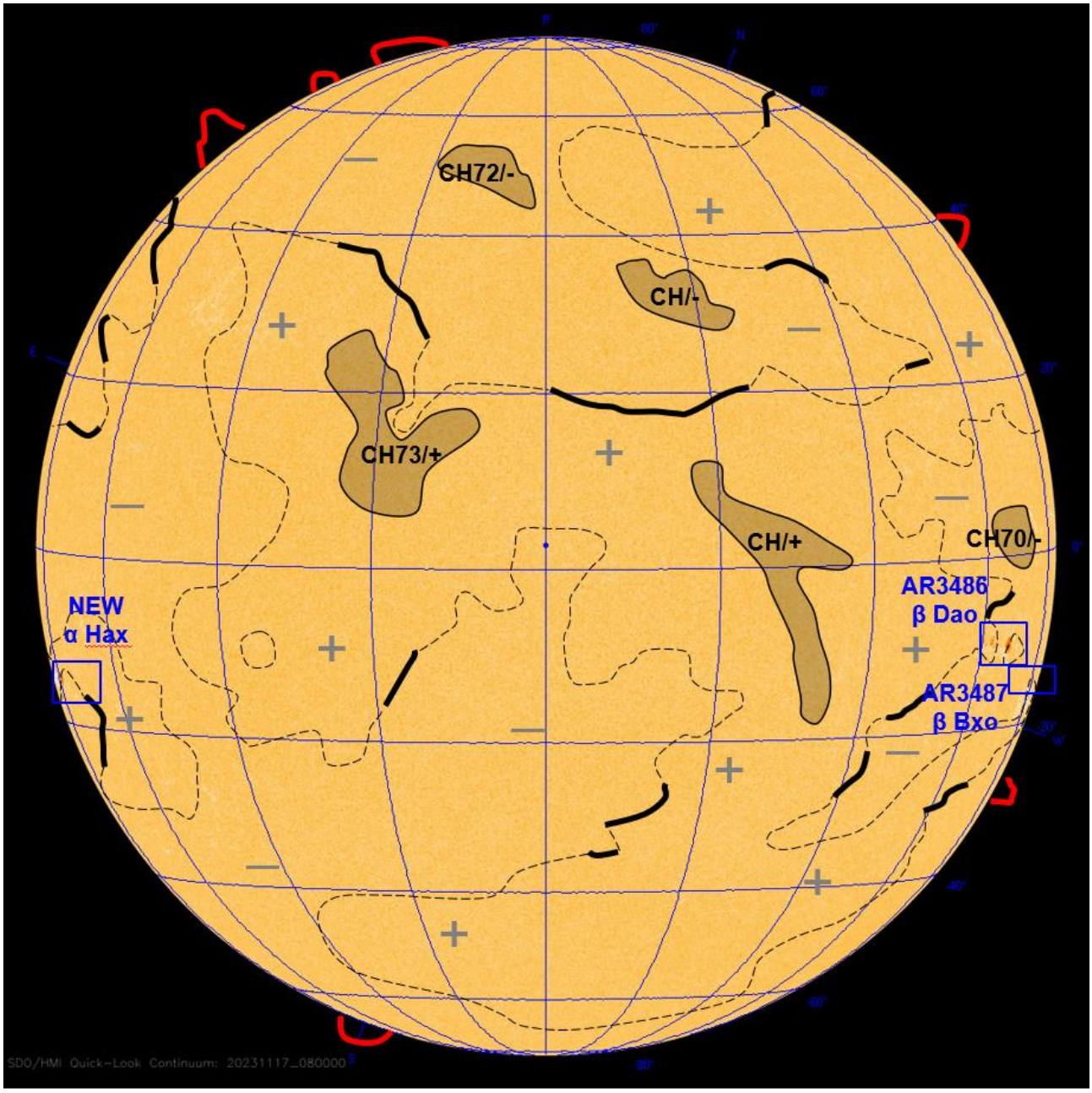
above mentioned CME, however there is significant uncertainty regarding details.

Energetic Particles / Solar Radiation: GOES16 High energy proton flux is expected to remain at Background. GOES16 High energy electron flux will likely continue at moderate through day 1 (17th) and 2 (18th), perhaps increasing to High levels from day 3 (19th). CME arrival on day 4 (20th) likely to return levels down to background. The associated 24-hour electron flux is expected to remain below the Active (1e8 integrated pfu) level, but perhaps with an increasing trend

Figure 1. Solar Analysis Valid 17/0800.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The CME associated with the 16/0100UTC filament eruption may reach Earth late on day 3 (19th) or into day 4 (20th), but confidence is low regarding this. There is a +/- 12 hour spread of arrival times as shown by Enlil ensembles. Further analysis of the CME has been undertaken, with the modelled results of the re-analysis now awaited. Recent evaluations show potential faster speeds for the CME than initially thought, perhaps giving the most likely arrival time early on day 4. Impacts however are most likely to be limited.

The solar wind is expected to remain at predominantly background levels today and much of tomorrow. Slightly elevated wind speeds may also occur from late tomorrow (18th) due to further coronal hole influence. This is from a feature which developed near centre disc, opening up after the filament eruption around 16/0100 UTC. The influence of this narrow coronal hole is likely to wane later in the period.

Geomagnetic activity is expected to remain predominantly Quiet (Kp 0-2), but with isolated Unsettled (Kp 3) intervals possible throughout, especially late tomorrow (18th) into day 3 (19th). There is a risk of a G1/minor storm (Kp5) on day 4 (20th) due to the possible arrival of the above mentioned CME, however there is significant uncertainty regarding details.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	1	5	5	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
16/1100	Partial	Filament Eruption	NW	400km/s	20/0600	Low confidence in timing, +/- 12 hours.

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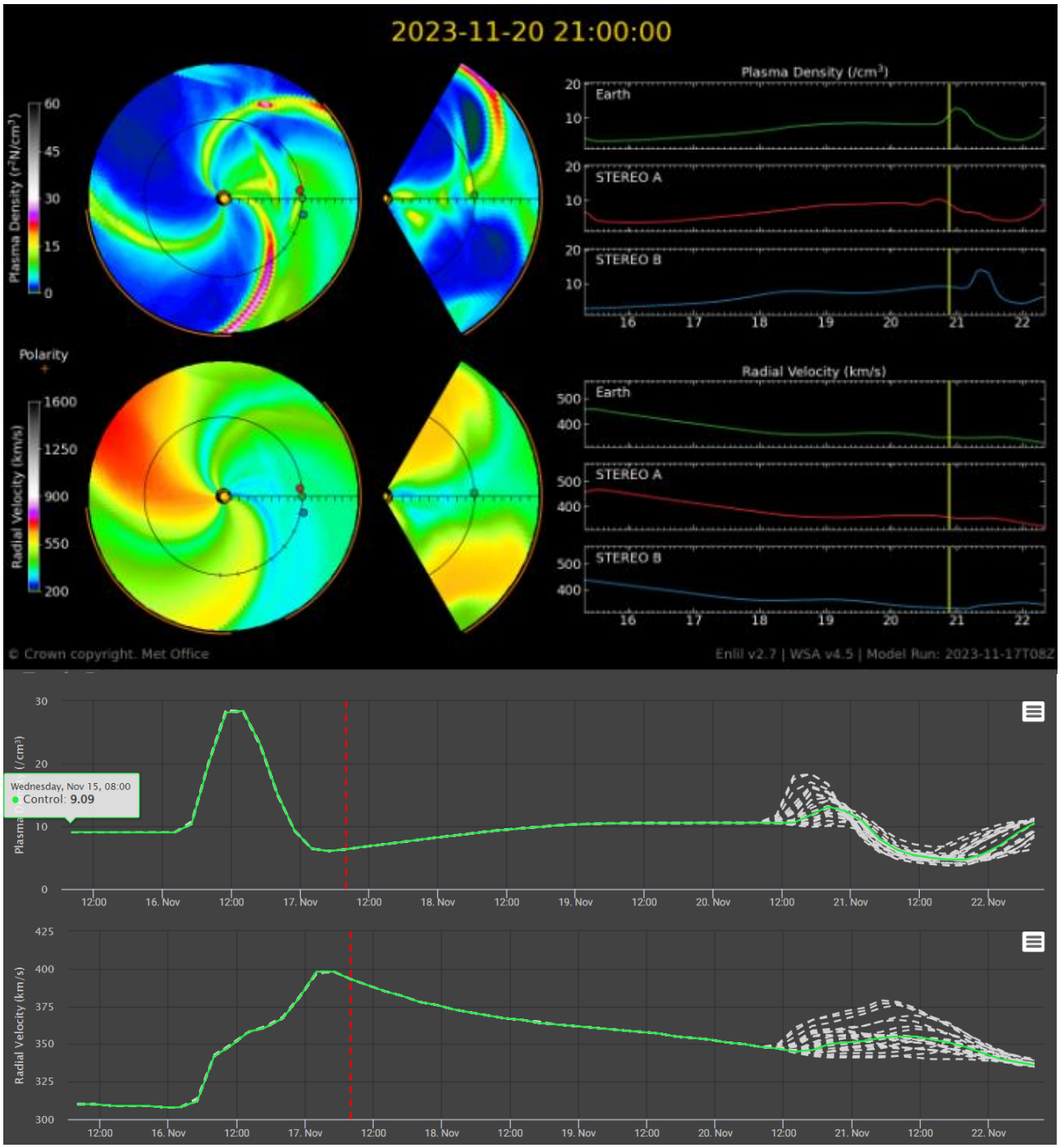
Figure 2: Latest MOSWOC Enlil ensemble forecast (Does not show last modifications to CME which are likely to have slightly faster arrival times)



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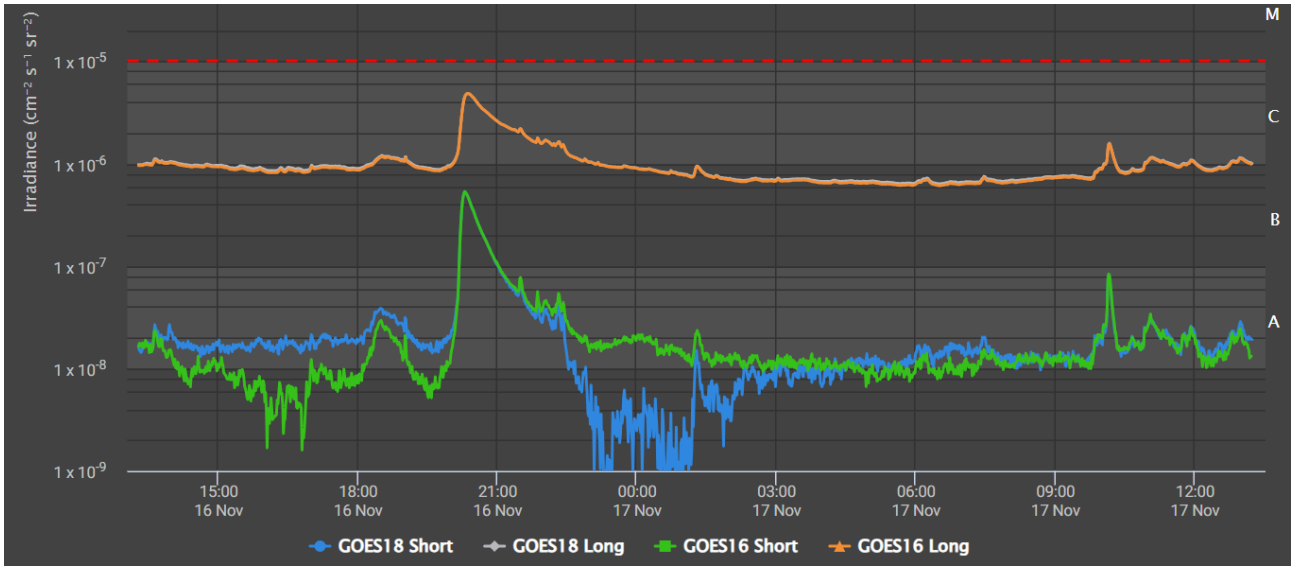
Radio Blackouts - X-Ray Flares:

There are currently only two numbered sunspots on the visible disc. Of these AR3486 remains the largest and most complex. AR3487 remains small, weak and relatively magnetically simple and appears to be fading, but this could be due to the proximity of the west limb. A new region is currently rotating onto the southeast limb, and due to its location is hard to analyse. This now appears to have two spots visible but it is too early to tell if they have the same or opposite polarities, likely to be updated as the region rotates from the limb.

Low activity has been observed over the last 24 hours, with isolated C-class flares, the largest of which a C4 peaking at 16/2022 UTC from a new sunspot region that is now rotating onto the southeast limb. There are also some indications of further active regions, currently on the far side, rotating onto the eastern limb in the coming days, giving an increasing chance of further M flares going forward.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	20	25	30	30
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: X-ray trace from GOES 16 and 18



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Solar Radiation Storms - (High Energy Protons):

The high energy (greater then 10Mev) proton flux observed by GOES16 is currently at Background levels and expected to persist at this level. The main risk of any increase to the proton flux will be from any notable filament eruptions, however these are currently considered unlikely to reach the S1 level.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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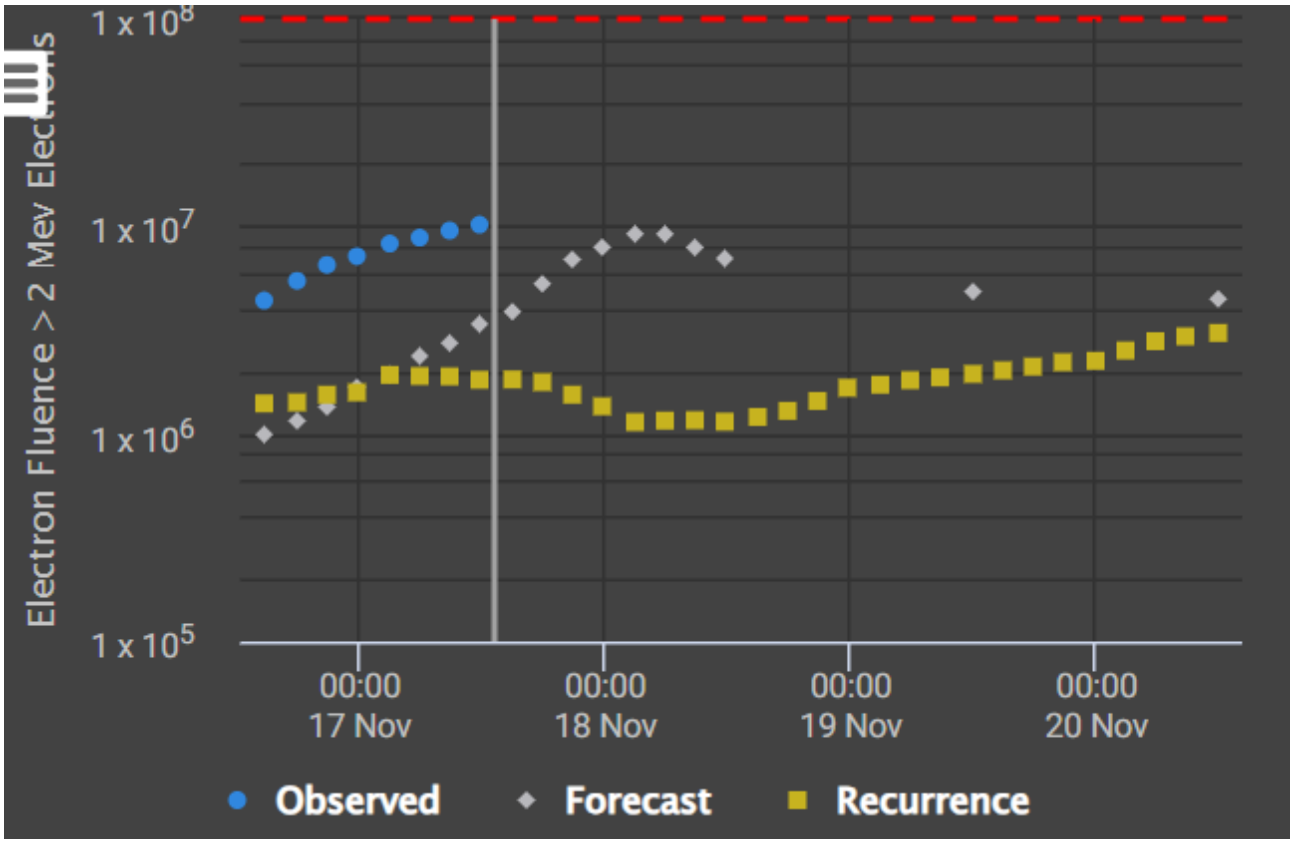
High Energy Electrons Event (≥ 2MeV):
GOES16 High energy electron flux is currently at moderate levels and will likely continue at moderate through day 1 (17th) and 2 (18th), perhaps increasing to High levels from day 3 (19th) due to a weak high speed stream from the newly developed narrow coronal hole feature in the western hemisphere. CME arrival on day 4 (20th) likely to return levels down to background. The associated 24-hour electron flux is expected to remain below the Active (1e8 integrated pfu) level, but perhaps with an increasing trend, which is not shown by the Met Office REFM model. However, the REFM model does show the fluence remaining below the Active threshold, which is accepted.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	5	10	10
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 4: Latest MOSWOC REFM model.



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